

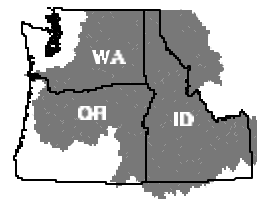
EXECUTIVE SUMMARY

Introduction

This report presents the results of an assessment of chemical pollutants in fish and the potential risks from consuming these fish. The fish were collected throughout the Columbia River Basin in Washington, Oregon, and Idaho.

After reviewing the results of the U.S. Environmental Protection Agency (USEPA. 1992a) 1989 national survey of pollutants in fish in the United States, EPA became concerned about the potential health threat to Native Americans who consume fish from the Columbia River Basin. The Columbia River Intertribal Fish Commission (CRITFC) and its member tribes (Warm Springs Tribe, Yakama Nation, Umatilla Confederated Tribes, Nez Perce Tribe) were also concerned for tribal members who consume more fish than non-Indians.

Map of Columbia River Basin



In order to evaluate the likelihood that tribal people may be exposed to high levels of contaminants in fish tissue EPA, CRITFC and its member tribes, designed a study in two phases. The first phase was a fish consumption survey which was conducted by the staff of CRITFC and its member tribes. The fish consumption survey was completed in 1994 (CRITFC 1994). The conclusions of the tribal survey were:

“The rates of tribal members’ consumption across gender, age groups, persons who live on- vs. off-reservation, fish consumers only, seasons, nursing mothers, fishers, and non-fishers range from 6 to 11 times higher than the national estimate used by USEPA.”(quote from CRITFC, 1994, Page 59)

The results of the fish consumption survey accentuated the need to complete an assessment of chemicals in the fish being consumed by CRITFC’s member tribes.

In 1994, EPA and CRITFC’s member tribes initiated the second phase of the study which was a survey of contaminants in fish tissue in the Columbia River Basin and the subject of this report. The contaminant survey was designed by a multi-agency group including CRITFC, Washington Departments of Ecology and Health, Oregon Departments of Environmental Quality and Health, the Confederated Tribes of Warm Springs, the Yakama Nation, the Umatilla Confederated Tribes, the Nez Perce Tribe, U.S. Geological Survey, and U.S. Fish and Wildlife Service. Sample collection took place between 1996 and 1998 with the help of CRITFC’s member tribes and staff of federal and state agencies. Chemical analyses were completed in 1999. The analyses were done by EPA and commercial laboratories.

While the study was initiated because of concern for Native American tribes, the results are

important to all people who consume fish from the Columbia River Basin. This study provided EPA with information to determine:

- 1) if fish were contaminated with toxic chemicals,
- 2) the difference in chemical concentrations among fish species and study sites, and
- 3) the potential human health risks due to consumption of fish from the Columbia River Basin.

The results of this survey provided information on those chemicals which were most likely to be accumulated in fish tissue and therefore posed the greatest potential risks to people. These are the chemicals for which regulatory strategies need to be defined to reduce these chemicals in our environment.

This study was *not* designed to evaluate:

- 1) health of past or future generations of people who consume fish from the Columbia River Basin,
- 2) rates of disease in tribal communities,
- 3) specific sources of chemicals,
- 4) multiple exposures to chemicals from air, water, and soil,
- 5) food other than fish, and
- 6) risks for a specific tribe or individual.

It is our hope that the results of this survey will be used by CRITFC's member tribes as well as others to more completely evaluate and protect the quality of the fishery resource.

Study Design

This study was designed to estimate risks for a specific group of people (CRITFC's member tribes). Therefore, the sample location, fish species, tissue type, and chemicals were not randomly selected. Collection sites were selected because they were important to characterizing risks to CRITFC's member tribes. Chemicals were chosen because they were identified in other fish tissue surveys of the Columbia River Basin as well as being found throughout the environment.

This type of sampling is biased with unequal sample sizes and predetermined sample locations rather random. This bias is to be expected when attempting to provide information for

individuals or groups based on their preferences. The results of this survey should not be extrapolated to any other fish or fish from other locations.

A total of 281 samples of fish and fish eggs were collected from the Columbia River Basin. The fish species included five anadromous species (Pacific lamprey, smelt, coho salmon, fall and spring chinook salmon, steelhead) and six resident species (largescale sucker, bridgelip sucker, mountain whitefish, rainbow trout, white sturgeon, walleye). Four types of samples were collected: whole-body with scales, fillet with skin and scales, fillet without skin (white sturgeon only), and eggs. The fillets were all with skin except for the white sturgeon. The armor-like skin of the white sturgeon is considered too tough for ingestion. All the samples were composites of individual fish, except white sturgeon. The white sturgeon were analyzed as single fish instead of composites because of their large size. The number of fish in a composite varied with species, location, and tissue type. Eleven samples of eggs were collected from steelhead and salmon. Due to availability of fish, limitation in time and funds, certain species were not sampled as frequently as others. In particular, the bridgelip sucker, coho salmon, and eulachon were collected at only one location. Pacific lamprey and walleye were collected at only two locations. The type of tissue tested (whole body, fillet, egg) varied with species and sample location.

Three replicate samples for each fish type were collected from a total of 24 study sites. These sites were located on 16 rivers and creeks, including, Hood River, Little White Salmon River, Wind River, Fifteen Mile Creek, Wenatchee River, Willamette River, Deschutes River, Umatilla River, Thomas Creek, Meacham Creek, Klickitat River, Yakima River, Snake River, Clearwater River, Looking Glass Creek, and the mainstream Columbia River. Different species were collected from each site depending upon the fishing practices of CRITFC's member tribes. Despite these many variables, general trends in the monitoring of pollutants in these various species and tissues were evident.

The fish tissues were analyzed for 132 chemicals including 26 pesticides, 18 metals, 7 PCB Aroclors, 13 dioxin-like PCBs, 7 dioxin congeners, 10 furan congeners, and 51 miscellaneous organic chemicals. Of these 132 chemicals, 92 were detected. The most frequently detected chemicals in fish tissue were 14 metals, DDT and its structural analogs (DDD, DDE), chlordane and related compounds (*cis*-chlordane, *trans*-chlordane, *cis*-nonachlor, *trans*-nonachlor, and oxychlordane), PCBs (Aroclors¹ and dioxin-like PCBs), and chlorinated dioxin and furans.

Results

The fish tissue chemical concentrations were evaluated for each study site and for the whole basin. The results of the study showed that all species of fish had some levels of toxic chemicals in their tissues and in the eggs of chinook and coho salmon and steelhead. The fish tissue chemical concentrations were variable within fish (duplicate fillets), across tissue type (whole body and fillet), across species, and study sites. However, the chemical residues exhibited some

¹Aroclors = commercial formulation of mixtures of PCB congeners; Aroclors 1242, 1254, and 1260 were the only aroclors detected in fish tissue in our study

trends in distribution across species and locations. The concentration of organic chemicals in the salmonids (chinook and coho salmon, rainbow and steelhead trout) and eulachon were lower than any other species. The concentrations of organic chemicals in three species (white sturgeon, mountain whitefish, largescale sucker) and Pacific lamprey were higher than any other species. The concentrations of metals were more variable, with maximum levels of occurring in different species.

Of the 132 chemicals analyzed in this study, DDE, Aroclors, zinc, and aluminum were detected in the highest concentration in most of the fish tissues sampled throughout the basin. The basin-wide average concentrations for the organic chemicals (DDE, Aroclors, chlorinated dioxins and furans) ranged from non-detectable in the anadromous fish species to the highest levels in resident species. DDE, the most commonly found pesticide in fish tissue from our study, ranged from a basin-wide average of 11 ppb² in whole body eulachon to 620 ppb in whole body white sturgeon. The sum of Aroclors ranged from non-detectable in eulachon to 190 ppb in mountain whitefish fillets. sturgeon. Chlorinated dioxins and furans were found at low concentrations in fish species. The basin-wide average concentration of the sum of chlorinated dioxins and furans ranged from 0.0001 ppb in the walleye, largescale sucker, coho, and steelhead fillets, fall chinook salmon (whole body, fillet, egg) and steelhead eggs to 0.03 ppb in whole body white sturgeon.

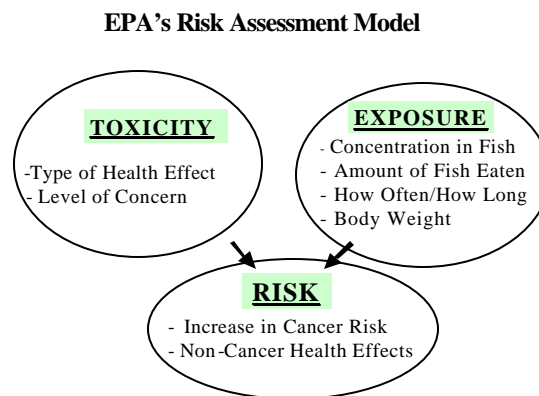
The concentration of metals did not show a distinct difference between anadromous and resident fish species. The basin-wide average concentrations of arsenic ranged from non-detectable in rainbow trout fillet to 890 ppb in whole body eulachon. Mercury ranged from non-detectable levels in Pacific lamprey fillets and whole body eulachon to 240 ppb in largescale sucker.

The distribution across stations was variable although fish collected from the Hanford Reach of the Columbia River and the Yakima River tended to have higher concentrations of organic chemicals than other study sites.

The chemical concentrations in fish species measured in this study were generally lower than levels reported in the literature from the early 1970's and similar to levels reported in the late 1980's to the present. The literature included studies from the Columbia River Basin as well as other water bodies in the United States.

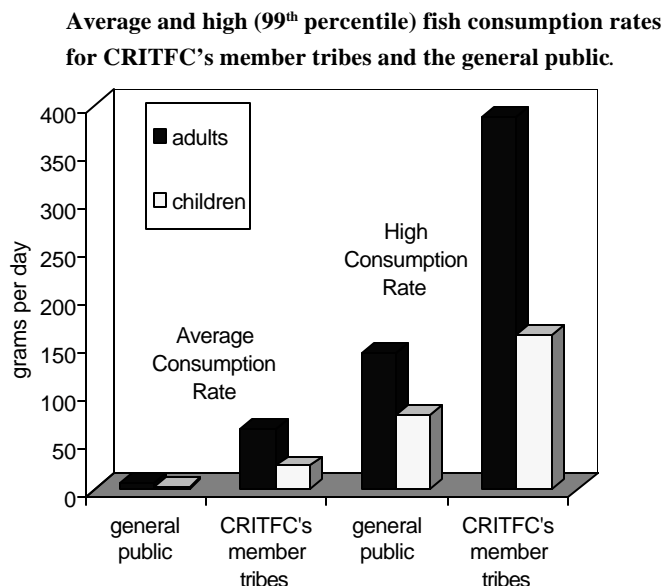
²ppb = parts per billion = µg/kg

EPA uses a risk model to characterize the possible health effects associated with chemical exposure. For this model, toxicity information is combined with estimates of exposure to characterize cancer risks and non-cancer health effects. Toxicity information (*reference doses and cancer slope factors*) used in this study was obtained from USEPA databases.



The EPA method to estimate exposure to chemicals in fish depends upon the chemical concentration in the fish tissue, the amount and types of fish eaten, how long and how often fish is eaten, and the body weight of the person eating the fish. For this assessment, exposures to chemicals were estimated for both adults and children of CRITFC's member tribes and the general population. In addition to estimating exposure for each site, exposures were also estimated for the basin wide average of fish tissue. In estimating these exposures, it was assumed that a person eats the same type of fish for their lifetime.

Different fish ingestion rates were used for the general public and for CRITFC's member tribes. Fish consumption rates for CRITFC's member tribes were based upon data from the CRITFC fish consumption survey (CRITFC, 1994) while those for the general public were based upon EPA analysis of national fish consumption rates (USEPA, 2000b).



In conducting a risk assessment, EPA evaluates the potential for developing non-cancer health effects such as immunological, reproductive, developmental, or nervous system disorders and for increased cancer risk. Different methods are used to estimate non-cancer health effects and cancer risks.

For non-cancer health effects, EPA assumes that a threshold of exposure exists below which

health effects are unlikely. To estimate non-cancer health effects, the estimated lifetime average daily dose of a chemical is compared to its *reference dose (RfD)*. The reference dose represents an estimate of a daily exposure level that is likely to be without deleterious effects in a lifetime. The ratio of the exposure level in humans to the *reference dose* is called a hazard quotient. To account for the fact that fish contained multiple chemicals, the hazard quotients for the chemicals which cause similar health effects were added to calculate a single hazard index for each type of health effect. For exposures resulting in hazard indices equal to or less than one, health impacts are unlikely. Generally, the higher hazard index is above one, the greater the level of concern for health effects.

For cancer, EPA assumes that any exposure to a carcinogen may increase the probability of getting cancer. Thus, the risk from exposure to a carcinogen is estimated as the increase in the probability or chance of developing cancer over a lifetime as a result of exposure to that chemical (e.g. an increased chance of 1 in 10,000). Cancer risks, which are calculated for adults only, are estimated by multiplying the lifetime average daily intake of a chemical by its *cancer slope factor*. The estimated cancer risk from exposure to a mixture of carcinogens is estimated by adding the cancer risks for each chemical in a mixture. The cancer risk estimates which are based on EPA's methodology are considered to be upper-bound estimates of risk or the most health-protective estimate. Due to our uncertainty in understanding the biological mechanisms which cause cancer, the true risks may in fact be substantially lower than the number estimated with EPA's risk assessment model.

In interpreting cancer risks, different federal and state agencies often have different levels of concern for cancer risks based upon their laws and regulations. EPA has not defined a level of concern for cancer. However, regulatory actions are often taken when the probability of risk of cancer is within the range of 1 in 1,000,000 to 1 in 10,000. Risk managers make their decisions regarding which level within this range is a concern depending on the circumstances of the particular exposure(s). A level of concern for cancer risk has not been defined for this risk assessment.

Using EPA's risk assessment models, hazard indices and cancer risks were estimated for people who consume resident and anadromous fish from the whole Columbia River Basin and from each study site in the basin. For adults, hazard indices and cancer risks were lowest for the general public at the average ingestion rate and highest for CRITFC's member tribes at the high ingestion rate. For adults in the general public with an average fish ingestion rate of about a meal³ per month (7.5 g/day), hazard indices were less than 1 and cancer risks were less than 1 in 10,000 except for a few of the more highly contaminated samples of mountain whitefish and white sturgeon. For adults in CRITFC's member tribes, at the highest fish ingestion rate at about 48 meals¹ per month (389 g/day), hazard indices were greater than 1 for several species at some sites. Hazard indices (less than or equal to 8 at most sites) and cancer risks (7 in 10,000 to 2 in 1,000) were lowest for salmon, steelhead, eulachon and rainbow trout and highest (hazard indices greater than 100 and cancer risks up to 2 in 100 at some sites) for mountain whitefish and white sturgeon.

³Meal = eight ounces of fish

For the general public, the hazard indices for children at the average fish ingestion rate were less for adults (0.9) at the average ingestion rate; the hazard indices for children at the high ingestion rate were 1.3 times greater than those for adults at the high ingestion rate. For CRITFC's member tribes, the hazard indices for children at the average and high ingestion rates were 1.9 times greater than those for adults in CRITFC's member tribes at the average and high ingestion rates, respectively.

For both resident and anadromous species, the major contributors to the hazard indices were PCBs (Aroclors) and mercury. DDT and its structural analogs were also important contributors for some resident species. The chemicals and or chemical classes that contributed the most to cancer risk for most of the resident fish were PCBs (Aroclors and dioxin-like PCBs), chlorinated dioxins and furans, and a limited number of pesticides. For most of the anadromous fish, the chemicals that contributed the most to cancer risk were PCBs (Aroclors and dioxin-like PCBs), chlorinated dioxins and furans, and arsenic.

In estimating hazard indices and cancer risks for people who eat a certain fish species, it is assumed that they eat only that type of fish for their lifetime. However, many people eat a variety of fish over a lifetime. Hazard indices and cancer risks were also estimated using a hypothetical multiple species diet. This hypothetical multiple species diet was based upon information from the CRITFC fish consumption study (CRITFC, 1994). The hazard indices and cancer risks for the multiple species diet were lower than those for most contaminated species of fish and greater than those for some of the least contaminated species. The risks for eating one type of fish may be an over or underestimate of the risks for consumers of a multiple-species diet depending upon the types of fish and concentration of chemicals in the fish which make up the diet.

The risk assessment model for assessing exposure to lead is different from other chemicals. Lead risk is based on a bio-kinetic model which includes all routes of exposure (ingestion of food, soil, water, and inhalation of dust). Based on EPA's risk assessment model, the lead concentrations in Columbia River Basin fish tissues were estimated to be unlikely to cause a human blood lead level greater than 10 µg/dl. The blood lead level of 10 µg/dl is the national level of concern for young children and fetuses (CDC, 1991).

In addition to the survey of the basin for the 131 chemicals, a special study of radionuclides was completed for a limited number of samples. White sturgeon were collected from the Hanford Reach of the Columbia River, artificial ponds on the Hanford Reservation, and from the upper Snake River and analyzed for radionuclides. The levels of radionuclides in fish tissue from Hanford Reach of the Columbia River and the ponds on the Hanford Reservation were similar to levels in fish from the Snake River. Cancer risks were estimated for consumption of fish which were contaminated with radionuclides. These risks estimates were not combined with the potential risks from other chemicals at these study sites. The potential cancer risks from consuming fish collected from Hanford Reach and the artificial ponds on the Hanford Reservation were similar to cancer risks in fish collected from the upper Snake River.

Conclusions

The concentration of toxic chemicals found in fish from the Columbia River Basin may be a risk to the health of people who eat them depending on:

- 1) the toxicity of the chemicals,
- 2) the concentration in the fish,
- 3) the species and tissue type of the fish, and
- 3) how much and how often fish is consumed

The chemicals which contribute the most to the hazard indices and cancer risks are the persistent bioaccumulative chemicals (PCBs, DDE, chlorinated dioxins and furans) as well as some naturally occurring chemicals (arsenic, mercury). Some pollutants persist in the food chain largely due to past practices in the United States and global dispersion from outside North America. Although some of these chemicals are no longer allowed to be used in the United States, a survey of the literature indicates that these chemical residues continue to accumulate in a variety of foods including fish. Human activities can alter the distribution of the naturally occurring metals (e.g. mining, fuel combustion) and thus increase the likelihood of exposure to toxic levels of these chemicals through inhalation or ingestion of food and water.

Many of the chemical residues in fish identified in this study are not unlike levels found in fish from other studies in comparable aquatic environments in North America. The concern raised in the Columbia River Basin also gives rise to a much broader issue for water bodies throughout the United States. The results of this study, therefore, have implications not only for tribal members but also the general public.

While contaminants remain in fish, it is useful for people to consider ways to still derive beneficial effects of eating fish, while

Recommendations for eating fish

EPA recommends that people follow the general advice provided by the health departments for preparing and cooking fish;

***Remove fat and skin before cooking**

***While cooking, allow fat and oil to drain**

These preparation and cooking methods should help to reduce exposures to PCBs, DDTs, dioxins, and furans, and other organics which accumulate in the fatty tissues of fish.

Note: It is also important to consider the health benefits of eating fish. While fish accumulate chemicals from the environment they are also an excellent source of protein that is low in saturated fats, rich in vitamin D and omega-3 fatty acids, as well as other nutrients.

at the same time reducing exposure to these chemicals. Fish are a good source of protein, low in saturated fats, and contain oils which may prevent coronary heart disease. Risks can be reduced by decreasing the amount of fish consumed, by preparing and cooking fish to reduce contaminant levels, or by selecting fish species which tend to have lower concentrations of contaminants.

The results of this study confirm the need for regulatory agencies to continue to pursue rigorous controls on environmental pollutants and to continue to significantly reduce those pollutants which have been dispersed into our ecosystems. Reducing dietary exposure through cooking or by eating a variety of fish will not eliminate these chemicals from the environment. Elimination of many of the man-made chemicals from the environment will take decades to centuries. Regulatory limits for new waste streams and clean up of existing sources of chemical wastes can help to reduce exposure. The exposure to naturally occurring chemicals can be reduced through better management of our natural resources.

There are many uncertainties in this risk assessment which could result in alternate estimates of risk. These uncertainties include our limited knowledge of the mechanisms which cause disease, the variability of contaminants in fish and fish ingestion rates, and the effects of food preparation. The uncertainties in our estimates may increase or decrease the risk estimates reported in this study.